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EVALUATION OF SELECTED COMMERCIAL CONSTRUCTION EQUIPMENT FOR BOMB DAMAGE REPAIR

E.F. ALEXANDER, and R.W. GRAHN

ENGINEERING RESEARCH DIVISION
RAPID RUNWAY REPAIR BRANCH

MARCH 1984

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Front End Loaders
Damaged Concrete Removal

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Three pieces of commercial equipment, a loader, an excavator, and a combination loader/backhoe, were evaluated for use in rapid repair of damaged airfields. The equipment was evaluated for their ability to remove damaged, upheaved concrete from around bomb craters. The actual force required to remove damaged concrete was also measured on an explosively formed crater. The force required was found to be in the 20,000-25,000 lb range. Of the three pieces of equipment evaluated, the most capable was the large front-end loader; (continued on back of sheet)

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however, it was found to be too large for the smaller craters. The hydraulic excavator would be the best machine for the job if it had at least 25,000 pounds of breakout force.

PREFACE

This report was prepared by the Air Force Engineering and Services Center, Engineering and Services Laboratory (AFESC/RD), Tyndall Air Force Base, Florida, under Job Order Number 20546B10, Bomb Damage Repair Equipment Specifications. Data from this test resulted in the purchase of the largest rubber-tired hydraulic excavator commercially available for long-term field evaluation. This work was performed between January 1980 and June 1980. First Lieutenant R. William Grahn and Mr Edgar F. Alexander were AFESC/RDCR Project Officers.

This report discusses the use of selected commercial construction equipment for bomb damage repair. The report does not constitute an endorsement or rejection of any specific piece of equipment for Air Force use, nor can it be used for advertising a product.

This report has been reviewed by the Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be available to the general public, including foreign nationals.

This technical report has been reviewed and is approved for publication.

Edgar F. Alexander
EDGAR F. ALEXANDER
Mechanical Engineer

John E. Goin
JOHN E. GOIN, Lt Col, USAF
Chief, Engineering Research Division

James R. VanOrman
JAMES R. VAN ORMAN, GM-14
Chief, Rapid Runway Repair

Robert E. Boyer
ROBERT D. BOYER, Col, USAF
Director, Engineering and Services Laboratory

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SECTION I

INTRODUCTION

A. BACKGROUND

High-performance military aircraft depend on a high-quality pavement for launch and recovery operations. This dependency makes the airfield a prime target for enemy attack. Consequently, the rapid repair of weapon-damaged runways is critical to the prompt response required following an airbase attack. This urgent requirement has led to the Rapid Runway Repair (RRR) Research and Development Program of the Air Fc e Engineering and Services Center (AFESC/RDCR), Tyndall Air Forc ase, Florida.

Prior field exercises held at Tyndall Air Force Base and experiences in the field have identified the removal of damaged and upheaved concrete from around craters and camouflets as being a problem. The time and effort required to remove concrete with the present RRR equipment cause a serious delay in the repair process. Analytical studies (Reference 1) have been made to determine systems for rapid removal of damaged concrete. Concrete-cutting systems are being studied under a separate project. This report documents efforts to find a system to efficiently break out the damaged concrete.

B. OBJECTIVE

The objective of this project was to determine a generic class of equipment suitable for the concrete-removal task in the rapid runway repair scenario.

C. APPROACH

The purpose of this project was to evaluate commercial equipment currently available which could be used to remove damaged and upheaved pavement. Five pieces of commercially available construction equipment were evaluated to determine their ability to remove damaged concrete. The equipment evaluated for this report consisted of:

International Harvester TD-15C Dozer
Allis-Chalmers 745B Loader
International Harvester H-100C Loader
Pettibone BP-419 Loader/Backhoe
Drott 40 Cruz-Air Hydraulic Excavator

The TD-15C dozer is presently used for concrete removal in the RRR equipment kits. The machines were evaluated during crater repair using the crushed limestone technique. The equipment was also used and evaluated in day-to-day support activities around the laboratory's Test and Evaluation branch. The evaluation was conducted over a 3-month period, which allowed time for AFESC/RDCR equipment operators to become familiar with each

machine's abilities. A test was also done to measure the force required to remove a typical piece of upheaved and damaged concrete. This test was done to get an approximate figure for the amount of breakout force required in concrete removal equipment.

SECTION II

DESCRIPTION OF TESTS

A. TEST AREA

The equipment evaluations took place on the Explosive Crater Test Facility of the Air Force Engineering and Services Laboratory, Tyndall Air Force Base, Florida. The test facility consisted of a large concrete slab (Figure 1) where previous work with explosively formed craters had been conducted. One-half of the slab was overlayed with 4 inches of asphalt. The crater was exploded at a point in the pad to cause one-half of the crater to be in the asphalt overlay area and one-half in the concrete area. The day-to-day operations were conducted at the Air Force Engineering and Services Laboratory's Test and Evaluation Site and also at the Tyndall main base area in support of Tyndall's Base Civil Engineering Squadron. The concrete-removal pull test was done at the Explosive Crater Test Facility on some of the damaged concrete in the explosively formed crater.

B. EQUIPMENT

The machines used in the evaluation were all commercially available construction equipment. The machines were chosen to represent a wide spectrum of construction equipment sizes and types which had the potential to remove damaged concrete. Detailed machine specifications are in Appendix A.

1. TD-15C Dozer (Figure 2)

The International Harvester TD-15C tracked dozer was used as our standard of measure. These machines are used in the present RRR kit as the prime tool for removing damaged concrete from the bomb craters. The machine has some serious drawbacks, however, in this role. The removal must be done from within the crater, which means the crater must be large enough for the dozer to enter and maneuver around. Since the dozer is almost 16 feet long, the crater needs to be over 20 feet in diameter. A second drawback is the mode of operation of the dozer; it removes concrete by using its tractive force to drive up the side of the crater and push the concrete up and out. An alternate mode of operation is to use the ripper tooth to peel back the concrete from outside the crater (Figure 3). This latter method is only effective if the concrete is substantially cracked, very loose, and in very small pieces. The dozer is slow-moving when compared to the other machines in this test.

2. Allis-Chalmers 745B (Figure 4)

The Allis-Chalmers 745B, used in this test, is an Air Force Size 4 loader of the type presently used by the Air Force RED HORSE squadrons. It is also the size machine which will be

Figure 1. Explosive Crater Test Site Plan View

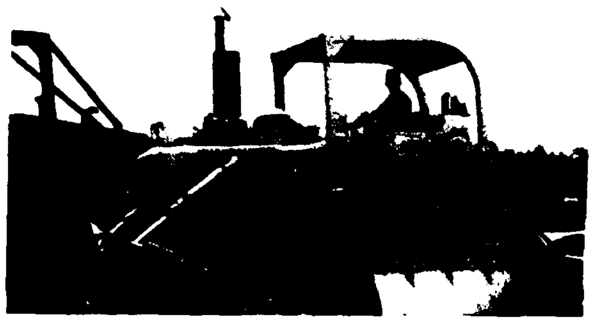

Figure 2. International Harvester TD-15C Dozer

Figure 3. TD-15C Using Ripper Tooth to Remove Concrete

Figure 4. Allis-Chalmers 745B Loader

bought as part of the Supplemental RRR Kit to augment the present 2.5-cubic yard loaders. The machine, a 1969 model, belonging to AFESC, had a Drott four-in-one 3.5-cubic yard bucket and no teeth. Due to the geometry and linkage of the bucket, the 745 has considerably more breakout force than other machines in its class. Machines such as the Caterpillar 966 and International Harvester H-90, both Size 4 machines, have breakout forces in the order of 23,000 to 25,000 pounds. The AC-745 has a breakout force of over 36,000 pounds, which is comparable to a Size 5 machine such as the H-100C loader also used in this test. Unfortunately, the AC-745B does not have the weight to make use of this considerable amount of breakout force. The loader removes damaged concrete from within the crater by using the breakout force of its bucket. This limits the loader and dozer because the machine must be inside the crater to remove the concrete. While the loader does not have to drive up the side of the crater to remove the concrete, the fact that it must work from within the crater severely limits its usefulness.

3. International Harvester H-100C (Figure 5)

The International Harvester loader is an Air Force Size 5 front-end loader equipped with a 5-cubic yard general-purpose bucket with teeth. The loader was a new machine rented from a local dealer and had a system which automatically stopped the raising of the bucket at any preselected height. This feature would be useful in rapidly loading the select fill onto trucks. A Size 5 loader was used in this test to determine if there was a practical limit to the physical size and weight of the loader in the RRR kit. Based on its weight and breakout force, the Size 5 loader should have been the most capable of removing concrete.

4. Pettibone BP-419 (Figure 6)

This machine is one of the largest, backhoe/bucket-loader combination machines. It carries a 1.5-cubic yard loader bucket and a 1/2-cubic yard backhoe bucket. It weighs almost 25,000 pounds and has approximately 15,000 pounds of breakout force at both the bucket and backhoe. That amount of breakout force puts the machine in the class of small hydraulic excavators. The Pettibone was selected to see if a large loader/ backhoe type machine could handle both backfilling of the crater and removal of damaged concrete.

5. Drott 40 Cruz-Air Hydraulic Excavator (Figure 7)

The Drott excavator is a large rubber-tired machine equipped with a concrete-removal bucket, wrist-o-twist, and a Y-type boom. This type of machine is used extensively in Europe in place of tracked bucket loaders. The machine was selected for this test because it could work outside of the crater and because it would not require additional support equipment for transportation. The machine in the test was rented from a local dealer and was 4 years old.

Figure 5. International Harvester H-100C Loader

Figure 6. Pettibone BP-419 Loader/Backhoe

Figure 7. Drott 40 Cruz-Air Hydraulic Excavator

C. TEST PROCEDURES

This evaluation was broken into three phases:

(1) Crater repair
(2) Damaged concrete pull test
(3) Day-to-day operations

The day-to-day operations portion of this test was interspersed between the crater repair and the damaged concrete pull test. The rented machines (H-100C Loader, Pettibone BP-419 Loader/Backhoe, and Drott 40 Cruz-Air Hydraulic Excavator) were operated daily on any task for which they could be used. The tasks included construction of the fire test pit on Tyndall main base by the Tyndall Civil Engineering Squadron in road and airfield maintenance, and in the modification of test aircraft shelters at the Engineering and Services Laboratory's Test and Evaluation Site.

1. Phase I - Crater Repair

The crater repair phase of the evaluation was done on an explosively formed 35-foot diameter crater on the Explosive Crater Test Pad. The crater was divided into three zones. The three rented pieces of equipment, the International Harvester H-100C loader, Pettibone BP-419 loader/backhoe, and the Drott 40 Cruz Air Hydraulic Excavator, were each used to remove concrete in one zone. The two pieces of equipment which belong to AFESC, the International Harvester TD-15 and the Allis-Chalmers 745C, were used on a smaller, previously formed crater at the crater facility. These two machines were not used on the explosively formed 35-foot diameter crater for two reasons. First, there was not enough room around the crater to give each piece of equipment a sufficient size or portion of the crater to repair and get any useful data; second, other craters were available for evaluation; and third, personnel were already very familiar with the capabilities of the TD-15 and the Allis-Chalmers 745C, based on past crater repair experience. The two craters would be repaired using the crushed limestone repair method and the repair would be trafficked with both the F-4 load cart and the C-141 load cart.

2. Phase II - Damaged Concrete Pull Test

To get a better idea of how much actual force was required to remove concrete from damaged craters, pieces of damaged concrete were selected from around the 35-foot diameter crater and pulled up by a crane with a load cell placed in the cable running from the crane down to the concrete slab.

3. Phase III - Day-to-Day Operations

Over the 3-month rental period,all of the machines were used in as many tasks as possible. The operators were then given questionnaires and asked to comment on the abilities and appropriateness of each piece of equipment for both day-to-day use and use in the RRR equipment kits.

SECTION III

FIELD TESTS

A. CRATER FORMATION

The crater used in this test was formed on the explosive crater test pad. A 2-foot diameter hole was drilled to a depth of 10 1/2 feet below the concrete surface. The crater was formed using 350 pounds of ammonium nitrate and 13 pounds of TNT. The apparent crater size was approximately 30-35 feet in diameter with the true crater size being 45 feet in one direction and 60 feet in the other (Figures 8 and 9).

The explosive crater test pad was originally built to accommodate six small craters. Clay cores 15 feet by 15 feet by 10 feet deep were placed at the predetermined locations of the six small craters on the test pad. The clay cores were put in place during construction and the clay was to simulate NATO-type subgrade conditions. The location where the crater for this test was exploded had 12 inches of Portland cement over 12 inches of base course, all of which were on top of a mixture of natural sand, crushed oyster shell, and limestone. This subgrade was the debris from the 1975-era crater test pad.

B. EQUIPMENT PERFORMANCE DURING CRATER REPAIR

In preparation for the damaged concrete removal tests, the loose debris around the crater was pushed back into the crater to bring the level of the bottom of the crater up to approximately 2 to 3 feet below the surface of the original concrete. This was done to allow the machines that operated within the crater a floor on which to work.

1. Pettibone BP-419 Loader/Backhoe

The Pettibone BP-419 was positioned outside the crater and attempted to remove concrete from around the crater. The machine could remove anything loose and broken into pieces not larger than 4 or 5 feet in any one direction. The Pettibone made no appreciable headway in removing any of the concrete that would have had to be removed for repair. The machine was located in four positions around the crater to attempt concrete removal. It could remove only concrete which was completely free and broken up. With 13,000 pounds of breakup force, the machine did not have power to do the job. The Pettibone, however, was stable on its outriggers and had no tendency to tip.

2. Drott 40 Cruz-Air Hydraulic Excavator

This machine was positioned perpendicular to the crater edge and attempted to remove upheaved concrete (Figure 10). It

Figure 8. Explosively Formed Crater

Figure 9. Crater Showing Extent of Damage

Figure 10. Drott 40 Cruz-Air Attempting to Remove Concrete

had 13,000 pounds of breakout force at the bucket and fared no better than the Pettibone in removing the concrete. With only one set of very light stabilizer pads, the Drott was unstable and did not encourage operator aggressiveness. At one point, the stick crowd force was employed and the machine was pulled forward towards the crater while on the pads, causing the pads to be bent backwards. This damage to the machine ended the concrete removal tests for the Drott.

3. Allis-Chalmers 745 Front-End Loader

This machine worked from the inside of the crater and attempted to use the breakout force of its bucket to remove the damaged concrete. This machine was successful in removing damaged concrete; however, it was obvious the breakout force of the machine was too much for the weight of the machine. The bucket could be pushed underneath the concrete and, because of the breakout force, could lift the machine off the ground without removing concrete.

4. International Harvester H-100C Front-End Loader

The H-100C worked from within the crater and removed all of the damaged concrete with no difficulty. The machine has almost 35,000 pounds of breakout force and weighs approximately 48,000 pounds. The combination of weight and breakout force removed even the most difficult pieces of concrete (Figure 11). The limitation of a machine of this size, however, is that the machine would be too big to maneuver inside a smaller crater and remove concrete without unnecessarily enlarging the crater.

5. International Harvester TD-15 Dozer

The TD-15 dozer was used on a separate crater, Number 5, (Figure 1). The TD-15 was used to remove upheaved concrete from within the crater to determine its capabilities in similar materials and concrete. The TD-15 proved capable of removing concrete as long as it could drive underneath it. The TD-15, while capable, was very slow. The machine took approximately 90-120 percent longer to remove a given portion of the crater when compared to the H-100C.

The four machines removed all of the damaged concrete from around the 35-foot crater. The result was a crater measuring 60 by 45 feet. The damaged concrete was taken to the nearest joint in the concrete slabs. At this point, 2 feet of clay were placed on top of the natural subgrade (Figure 12). Between 2 and 2 1/2 feet of crushed limestone were then placed on top of the clay and the crater was tested as a large crater repaired with the crushed limestone repair method. The crater was trafficked with F-4 and C-141 load carts and proved to be acceptable. Load cart testing of this crater is documented in a separate technical report.

Figure 11. H-100C Removing Damaged Concrete

Figure 12. Crater with Damaged Concrete Removed and Clay in Place

6. Summary

The results from this damaged concrete removal evaluation showed that both the Pettibone Backhoe and the Drott 40 Cruz-Air machines lacked sufficient breakout force to remove the type of damaged concrete that could be expected in a medium- to large-size crater. Unless the concrete was free and broken on all sides, these machines could not move the material. Both the International Harvester H-100C loader and the Allis-Chalmers 745C loader had sufficient breakout force to remove damaged concrete. They did, however, retain the disadvantage of requiring the crater to be backfilled to provide a floor on which they could operate. Another disadvantage to these loaders was the large size of both machines, which precluded them from working within small-size craters.

C. DAMAGED CONCRETE PULL TEST

A test was conducted to more accurately determine the amount of force to remove damaged concrete from around craters. The concrete removal bucket from the Drott was placed on a piece of damaged concrete to be removed. The bucket was put in place with the Drott and the pins holding the bucket on the machine were removed. A crane was put in place of the Drott and the cable from the crane, with a load cell in the crane's cable line, was attached to the concrete removal bucket (Figure 13). The crane then winched in the cable and pulled up the concrete. The force transmitted through the load cell was recorded on a strip chart recorder. This procedure was carried out six times to get an average force required. The slab was constrained on three sides with the fourth side of the slab being the edge of the crater. The 70,000-pound capacity load cell used was calibrated immediately before the test.

Table 1 shows the results of the pull test. The conclusion is that a machine with at least 25,000 pounds of breakout force would be capable of removing damaged concrete from craters.

D. DAY-TO-DAY OPERATIONS

All of the machines were operated as often as possible during the 3-month rental period. The majority of the machine hours were spent helping to construct a test fire pit.

The H-100C Loader was used to fill dump trucks hauling sand and crushed oyster shell. Approximately 120 hours were put on the loader during this phase of the test. No breakdowns or delays due to the machine were experienced.

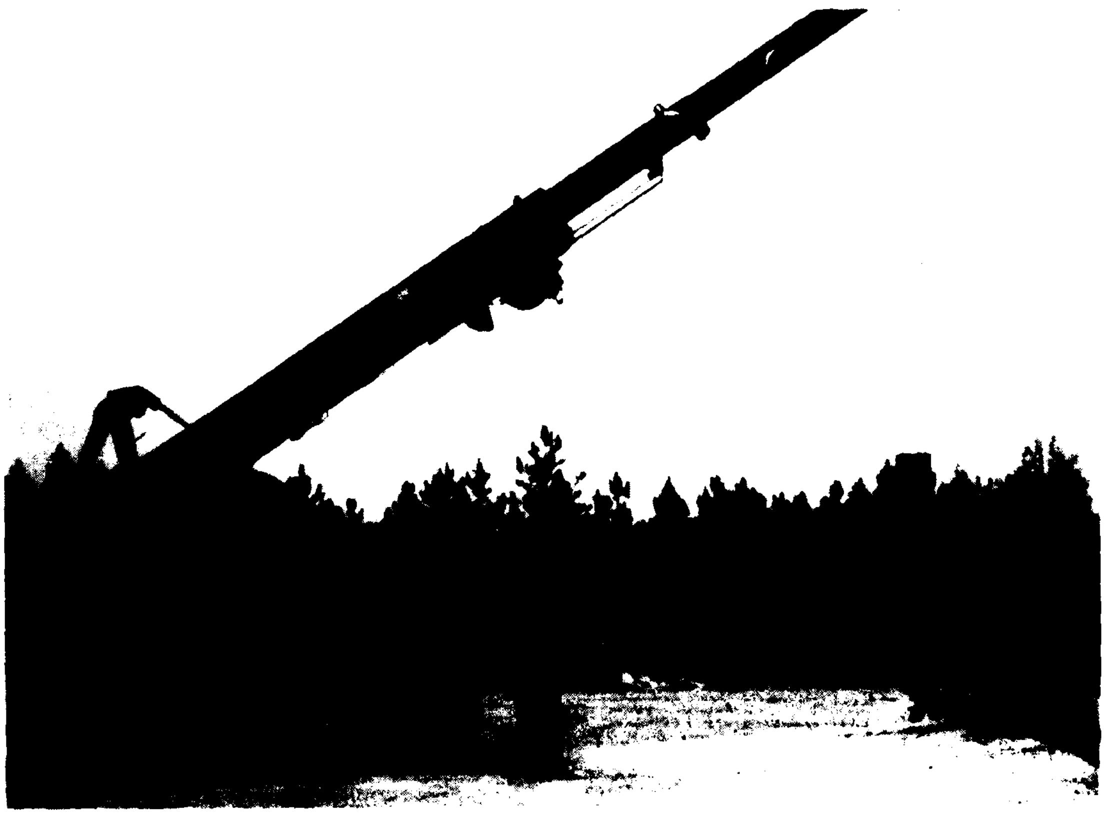

Figure 13. Concrete Removal Bucket and Load Cell

The Pettibone BP419 Loader/Backhoe was only used for 20 hours during this phase. The machine is a general-purpose piece of equipment. With specialized machines like the Drott and the H-100C available, the Pettibone was just not the best machine for the jobs to be done. The only downtime on the machine was caused by a broken voltage regulator.

The Drott 40 Cruz-Air Hydraulic Excavator was used extensively in ditch-cleaning operations around the test fire pit and around the base in general. The machine was ideally suited for this type of work. The only downtime on the excavator was due to a flat tire.

In Summary, for the day-to-day operations phase of the evaluation, the difference between routine base civil engineering work and RRR work was shown quite clearly.

The H-100C worked quite well, but was definitely oversized for day-to-day work. Some features of the machine would, however, be very useful in speeding up operations. Such features include the automatic bucket raise stop, the choice of two brake pedals (one with and one without automatic transmission disengagement), and the safety factor of the ignition key located outside the cab by the engine.

The Pettibone BP419 Loader/Backhoe proved to be a very good all-around machine, but was not as effective as specialized machines (Drott and H-100C).

The Drott 40 Cruz-Air proved to be excellent for ditch cleaning and light excavation.

TABLE 1. CONCRETE PULL TEST RESULTS

POSITION NO.	FORCED REQUIRED
1	18,500 lbs
2	5,000 lbs
3	22,750 lbs
4	5,600 lbs
5	25,000 lbs
6	7,000 lbs

SECTION IV

CONCLUSIONS

The Pettibone front-end loader/backhoe and the Drott 40 Cruz-Air hydraulic excavator with 13,000 pounds of breakout force did not have sufficient power to remove damaged concrete.

The International H-100C and the Allis-Chalmers 745B front-end loaders had sufficient power to remove the damaged concrete from within the crater. However, they required a crater large enough to be able to allow the machines to both maneuver inside the crater and get the bucket underneath the damaged concrete. These two requirements would limit the machine's usefulness in repairing small craters and camouflets.

Based on the results of the damaged concrete pull test, a machine with at least 25,000 pounds of breakout force would be required for concrete removal. Ideally, the machine should be capable of operating from outside of the crater.

Based on a comparison between the Allis-Chalmers 745 and the H-100C, the machine, which will be successful in removing concrete, should weigh at least 45,000 pounds.

SECTION V

RECOMMENDATIONS

Recommend a large hydraulic excavator equipped with rubber tires, four outrigger pads, an E-type boom, attachment quick-change mechanism, and at least 25,000 pounds of breakout force be obtained for evaluation in damaged concrete removal.

Recommend the excavator be equipped with a hydraulic hammer for evaluation in breaking up the concrete prior to removal.

REFERENCE LIST

1. Jack E. Baker, Bomb Damage Repair Equipment Concept Study, ESL TR 81-3, Air Force Engineering and Services Center, Tyndall AFB, Florida, September 1979.

APPENDIX A

EQUIPMENT SPECIFICATIONS

INTERNATIONAL HARVESTER TD-15C

ENGINE:

Make and Model..............................International DT-466B
Type........................4-cycle diesel, turbocharged, direct-start, direct-injection
*Net flywheel kW (horsepower) @ 2500 rated rpm...104(140)
RPM at maximum torque..1600
No. of cylinders...6
Displacement, litre (in^3)..............................7.63(466)
Bore and Stroke, mm (in.)...................................109x136(4.30x5.35)
Lubrication, full-flow Filtering.......................................Full-pressure
Number of main bearings..7
Electric system.......................................24 volt
Air cleaner.........................exhaust-aspirated, dry-type with safety element

*Net flywheel horsepower--output of standard engine complete with fan, air cleaner, alternator, water pump, lubricating oil plump and fuel pump under SAE standard temperature and barometric conditions of 99.2 kPa (29.38 in.) Hg and 29.4°C (85°F). No deration required up to 3048 m (10,000 feet) altitude.

TRANSMISSION & TORQUE CONVERTER

Simplified, countershaft-type power shift...hydraulically controlled and actuated. Single-stage 330 mm (13-inch) torque converter drives to transmission through a double universal joint.

TRAVEL SPEED RANGE

Gear Range	1st		2nd	
	km/h	(mph)	km/h	(mph)
Lo-Forward...	0-4.0	(0-2.5)	0-6.9	(0-4.3)
Hi-Forward...	0-5.8	(0-3.6)	0-9.6	(0-6.0)
Lo-Reverse...	0-4.6	(0-2.9)	0-8.0	(0-5.9)
Hi-Reverse...	0-6.7	(0-4.2)	0-11.2	(0-7.0)

STEERING

Single-stage planetary and multiple-disc brakes for feathered or pivot turns, controlled by hand lever for each track, with hydraulic-boosted assist. Single-foot pedal applies both track brakes for parking or downhill speed control.

FINAL DRIVES

Double reduction provides desired gear reduction at the working end of the power train. Ring-type sprocket...distributes wear evenly over track bushings letting every tooth ride free one-half of the time to reduce wear...replaceable without removing track frame.

TRACK FRAME

All-welded heavy channel section.
Number of track rollers each side.............................6
Number of top idlers each side................................2
Front idlers (drum type) bearings................Tapered roller
All rollers and idlers.......................Lifespan lubricated

TRACKS

Track shoe width standard, mm (in.).......................457(18)
Number of track shoes each side..............................39
Ground contact area with standard 457 mm (18-inch) shoes, cm^2 ($in.^2$)..22,343(3463)
Height of grouser, mm(in.)................................660(2.6)
Track adjustment...................................Fully hydraulic
Ground clearance from bottom face of shoe, mm (in.).....438(17.24)
Rigid drawbar--approx height from ground to centerline of 89 mm (3.5 in.) clevis, mm(in)...507 by 380 (19.95 or 14.95)

CAPACITIES: (Approx)

Fuel tank	302.80	(80)
Cooling system	41.64	(11)
Engine lubrication incl. filters	17.03	(4 1/2)
Transmission and rear frame	132.48	(35)
Sprocket drive, each side	20.82	(5 1/2)

WEIGHT: (Approx kg (lb)

Shipping with regular equipment (include ROPS, Dozer and Hydraulic control system)....................................14,297(32,520)

BLADE

Type Blade (hydraulic)........................Semi "U" Bulldozer
Model...15D-2

Maximum Usable Track Shoe Width

For maximum track oscillation, mm (in.)	559(22)	
Blade Dimensions: m (in.)		
Length, over regular end bits	3.15	(124.0)
Height, struts centered	1.14	(45.0)
Maximum lift, struts centered		
Straight	0.91	(35.9)
Angled	-	
Maximum drop below ground level	0.41	(16.3)
Maximum manual tilt adjustment	0.65	(25.5)
Blade angle, either side	-	
Maximum pitch adjustment	10°	

MOLDBOARD

Material	High-Strength manganese abrasion-resistant steel	
Construction	Full closed-back boxed frames	
Cutting Edge: Reversible, heat-treated, high-carbon steel, mm (in.)		
Length	2454	(96.6)
Width	203	(8.0)
Thickness	19	(.75)
End Bits: (2) (Regular) heat-treated, high-carbon Steel, mm (in.)	Formed	
Length	424	(16.7)
Width	236	(9.3)
Thickness	19	(.75)
End Bits: (2) (Optional) cast allow steel, mm (in.)		
Length	429	(16.9)
Width	236	(9.3)
Thickness	19	(.75)
Blade Lift Speed: (at rated engine rpm)		
M/S (F/S) average	0.49	(1.6)
Overall Dimensions: Tractor with blade mounted, m (in.)		
Length, blade straight	5.02	(197.7)
Length, blade angled	-	
Width, blade straight	3.15	(124.0)
Width, blade angled	-	
Width over trunions	2.73	(107.62)
Width of "C" frame	-	
Net Weight: (Without Control Unit) Approx kg(lb)	2073	(4570)

TD-15C

INTERNATIONAL RIPPER

SPECIFICATIONS

Overall Length on Tractor W/Bulldozer Mounted (approx)
Ripper with standard straight shanks @ max raise, m...5.69(18 ft, 8 in.)
Ripper with standard straight shanks @ max dig, m.....6.02(19 ft, 9 in.)

Maximum Overall Width of Tractor and Ripper
Tractor with ripper only, m............................2.34(7 ft, 10 in.)
Ripper with blade, m...................................3.15(10 ft, 4 in.)
Clearances:
Rear Main Frame-face to tooth tip
Ripper up, m...0.75(2 ft, 5.7 in.)
Ripper down, m...1.13(3 ft, 8.5 in.)

Tool Beam
Construction type Material..................Welded, box section, steel
Ground clearance under tool beam:
Ripper raised, m...............................1.03(3 ft, 4.7 in.)
Ripper lowered, mm.................................116.8(4.6 in.)
Overall length, m..............................2.13(6 ft, 1.8 in.)
Cross Section, mm.........................228x254(9 in. x 10 in.)

Shank
Material...Alloy steel
Length w/tooth, m.............................0.88(2 ft, 10.8 in.)
Section,mm...............................64x190(2.5 in x 7.5 in.)
Spacing center to center, mm......................483(19.0 in.)
Number of shanks per ripper.........................1, 2, 3, 4, 5
Penetration: standard, mm..........................498(19.6 in.)
Ground clearance, shank, under tooth
at maximum raise,mm.............................530(20.9 in.)
Shank positions (vertical)...................................2

Points
Type...Replaceable
Attachment method.......................................Flex pin
Material................................Alloy steel for shanks
Length (standard), mm..............................259(10.2 in.)

Hydraulic Lift System
Number of cylinders (double-acting)..........................1
Bore and stroke, mm...................(165x401(6.5 in. x15.8 in.)
Rod Diameter, mm......................................64(2.5 in.)

Weight, kg (lb.) (approx)
Complete, including one standard straight shank...........1460(3219)
Each additional straight shank..............................72(158)

ALLIS-CHALMERS 745-C SPECIFICATIONS

ENGINE

Make...Allis-Chalmers
Model............................11000 Mark II turbocharged diesel
*Flywheel horsepower......................................202
**Kilowatts...151
Governed rpm...2200
Maximum torque
  ft-lb. @ rpm.............................575 ft-lb. @ 1600 rpm
  kg-m @ rpm...............................79.5 kgm @ 1600 rpm
Bore and stroke................4.44 in. x 5.56 in. (112 x 141 mm)
Number of cylinders...6
Displacement.............................516 cut in. (8.46 l)

*Net flywheel horsepower available at the flywheel of the vehicle engine under SAE J816b standard conditions of 85°F (29°C) and 29.38 in. (746 mm) hg after deductions have been made for fan. Alternator compressor, lube oil pump, water pump, air cleaner, muffler and fuel pump engine will maintain specific flywheel horsepower up to 5,000 ft (1520 m) altitude.

**The International System of Units for power one (1) horsepower equals 0.746 kilowatts in USA units.

TORQUE CONVERTER

Type..Twin-turbine
Torque multiplication....................................4.62 to 1

TRANSMISSION

Type.......................................Power shift planetary

Forward speeds	mph	km/hr
1	2.4	3.8
2	5.3	8.5
3	9.2	14.8
4	20.0	32.1
Reverse speeds		
1	3.4	5.4
2	7.3	11.7

SOF-SHIFT transmission permits full-power directional shift changes in low ranges for fast cycle time. Shifts from 1st to 2nd and 3rd to 4th are automatic.

AXLES

Planetary reduction at wheel end. Axle shafts removable, independent of wheel and brakes. Torque-proportioning differentials. Axle housings pin-connected to loader frame.

Rear axle oscillation...22°
Vertical travel.................................17 in. (432 mm)

BRAKE SYSTEMS

Service--4-wheel caliber disc-type, air over hydraulic power, dual system.
Emergency--dash-mounted lever actuates services brakes.
Parking--mechanically actuated drum brake on drive line.

TIRES

Type...Tubeless
Standard....................................23.5 - 25 (16 PR) L3
Optional........................23.5 - 25 (20 PR) L2, L3, L4, L5,
26.5 - 25 (20 PR) L2, L3

ELECTRICAL SYSTEM

Voltage...24 V
Standard alternator.....................................40 amp
Battery amp/hour rating.................................180
System protected by circuit brakers

LOADER HYDRAULIC SYSTEM

Type......................Closed with pressure & vacuum relief
Cylinders......................................Double acting
Lift(2).....................6.5 in. x 35.75 in. (165 x 908 mm)
Dump(2).....................6.0 in. x 39.5 in. (152 x 1003 mm)
Pump.......................................Gear type, tandem
Capacity @ governed rpm.................95.0 gmp (359.6 lt/min)
Control valve...................................Two spool
Relief valve pressure.................. 2000 psi (140 kg/cm2)
Lift time.......................................6.5 sec
Lower time......................................4.6 sec
Dump time.......................................2.6 sec

STEERING SYSTEM

Type.......................................Hydraulic power*
Cylinders..................................Two, double acting
Bore and stroke.................3.5 in. x 20.75 in. (89 x 527 mm)
Pump...Gear type
Capacity @ governed rpm.................36.0 gpm (136.3 l/min)

*With demand valve interconnection to loader hydraulic system, and mechanical followup linkage.

FILTRATION SYSTEMS

ENGINE
- Lube oil....................................Full-flow 25-micron
- Fuel........................Full flow 5-micron w/water separator
- Air cleaner...........................Dry type w/safety element
- Coolant.....................................Filter/conditioner

TRANSMISSION-TORQUE CONVERTER
- Oil...Full-flow 25-micron

HYDRAULIC
- Oil...Full-flow 25-micron
  Full-flow magnetic
  Full-flow wire mesh
- Pressure-vacuum relief........................40-micron element

CAPACITIES

ENGINE
- Lube oil....................................7.5 US gal (28.4 l)
- Coolant...................................13.25 US gal (50.2 l)
- Fuel tank.................................85.0 US gal (321.8 l)

TRANSMISSION..................................9.25 US gal (35.0 l)
HYDRAULIC SYSTEM..............................57.0 US gal (215.8 l)
AXLES.................................11.5 US gal (43.5 l) each

		General Purpose	
BUCKET CAPACITY RATED	3.5 yd^3	4.0 yd^3	4.5 yd^3
STRUCK CAPACITY	3.0 yd^3	3.4 yd^3	3.8 yd^3
BUCKET WEIGHT	3000 lb	3182 lb	3364 lb
BUCKET WIDTH	118 in.	118 in.	118 in.
DUMP HEIGHT @ 45	10 ft, 4 in.	10 ft, 1 in.	9 ft, 11 in.
REACH @ 45°	33 in.	35 in.	38 in.
REACH @ 45° 7 ft (2134 mm)	68 in.	69 in.	71 in.
OVERALL LENGTH (BUCKET ON GROUND)	23 ft, 10 in.	24 ft, 2 in.	24 ft, 4 in.
OVERALL HEIGHT (BUCKET RAISED)	17 ft, 1 in.	17 ft, 4 in.	17 ft, 8 in.
CLEARANCE CIRCLE (BUCKET @ CARRY)	39 ft, 8 in.	39 ft, 10 in.	40 ft, 0 in.
BREAKOUT FORCE	39,690 lb	36,220 lb	33,280 lb
TIPPING LOAD			
0°	29,650 lb	29,190 lb	28,690 lb
35°	26,420 lb	25,990 lb	25,510 lb
40°	25,490 lb	25,060 lb	24,590 lb
45°	24,450 lb	40,030 lb	23,570 lb
OPERATING WEIGHT	40,180 lb	40,360 lb	40,540 lb

DROTT 40 CRUZ-AIR HYDRAULIC EXCAVATOR

POWER UNIT

	Detroit Diesel
Model	4.53"N"
No of Cylinders	4
SAE Gross HP	123 @ 2400 rpm
SAE Net HP	122 @ 2400 rpm

Fuel Supply ___________ 50 Gal (180 l)

CARRIER & PERFORMANCE

AXLES

Planetary with torque proportioning differentials. Four-wheel drive with front-wheel steering. Front axle oscillates and is equipped with oscillation lock.

TIRE SIZES

Standard:
Super Group Grip.................................13:00x24(12P-R)
Optional:
Super Ground Grip.............................17:50x25(12-PR)
Rock Service Grip.............................17:50x25(16-PR)

OUTRIGGERS (2 STANDARD-4 OPTIONAL)

Individually or simultaneously controlled from cab:

Lowering time...2.5 sec
Raising time..2 sec

DRAWBAR PULL

(Standard Trans)	(Optional Trans)
1st.....14,670 lbs(6654 kg)	1st.....19,750 lb
2nd..... 6,890 lbs(3125 kg)	2nd..... 9,350 lb
3rd..... 4,370 lbs(1982 kg)	3rd..... 5,950 lb
4th..... 1,890 lbs (857 kg)	4th..... 2,660 lb

HYDRAULIC SYSTEM

Tandem gear-type pumps 94 gpm (355 lpm) @ 2400 RPM double-acting cylinders for lift, crowd, tool and outriggers:

Lift cylinder..6 1/2 in.
Tool cylinder..5 1/2 in.
Crowd cylinder.......................................6 1/2 in.
Outrigger cylinder...................................5 1/2 in.

Relief pressure settings.............................2500 psi
Hydraulic capacity, complete...........................33 gal
Valves, monoblock, self-centering (auxiliary spool standard equipment)

Swing--Continuous @ 6.2 RPM..............................360°

BREAKOUT FORCE

"E" BOOM

Crowd...11,110 lb
Bucket..13,185 lb

"Y" BOOM

Crowd..8,790 lb
Bucket..13,185 lb

MAXIMUM GRADABILITY (CONCRETE)
No load, with 17:50 x 25 tires...........................60%

Transmission

Four-speed selective gear transmission with button-operated forward-reverse control and torque converter.

Parking Brakes:
Location...Drive Shaft
Type............................Spring-applied, air-released
Control...hand

Service Brakes
Location.......................................at each wheel
Type...air/hydraulic
Control..foot-operated

Digging Breaks
Location.......................................at each wheel
Type...air/hydraulic
Control...hand

ROAD SPEEDS

MPH - Forward- and Reverse-equipped w/17:50 x 25 tires

(Standard Trans	(Optional Trans)
1st......4.72	1st......3.34
2nd......9.75	2nd... ..7.30
3rd.....14.90	3rd.....11.20
4th.....30.70	4th.....23.10

BUCKETS

WIDTH	CAPACITY YD (STRUCK)	TYPE	WEIGHT
24 in.	1/2 yd3	Gen Purpose	950
30 in.	5/8 yd3	Gen Purpose	1050
36 in.	3/4 yd3	Gen Purpose	1175
42 in.	7/8 yd3	Gen Purpose	1000
60 in.	5/8 yd3	Ditch-Forming	725
60 in.	1 1/2 yd3	Front Loader	1096
60 in.	1 1/4 yd3	4-in-1	1210

For heaped capacities, add approx 20 percent

"Y" BOOM OPERATING SPECIFICATIONS (WITH WRIST-O-TWIST AND DITCH FORMING BUCKET)

DIMENSION DESCRIPTION	*EXTENSION EXTENDED	*EXTENSION RETRACTED
Maximum reach at grade level **	30 ft, 1 in.	26 ft
Maximum digging depth **	18 ft, 10 in.	14 ft, 10 in.
Maximum depth of cut for 8 ft level bottom (straight cleanup)	18 ft, 6 in.	14 ft, 6 in.
Radius of bucket teeth at maximum boom elevation-dipper arm fully extended bucket swing full in	19 ft, 7 in.	16 ft, 1 in.
Minimum vertical clearance of bucket teeth graded at maximum height	19 ft, 2 in.	17 ft, 4 in.
Cutting edge distance from grade end of highest dump *	27 ft, 2 in.	25 ft, 6 in.
Maximum height of bucket *	27 ft, 2 in.	25 ft, 6 in.
Dipper sweep angle	170°	
Boom length from boom foot pin to boom point pin	11 ft, 9 in.	11 ft, 9 in.
Minimum radius of 8 ft level bottom at maximum depth	5 ft	4 ft, 5 in.

Note:

*All dimensions are with hoist cylinder pin in upper pin hole and crowd cylinder pin in lower pin hole.

**For units not equipped with Wrist-O-Twist, deduct 14 inches.

INTERNATIONAL H-100C LOADER

ENGINE

Make and model..............................International-DT-817C
Type.........4-cycle diesel, turbocharged, direct-start, direct-injection.
*Rated kW (horsepower).................................240 (320)
**Flywheel kW (horsepower)..............................215 (290)
governed rpm...2100
Maximum torque
N-M..1208
(lb lt)..(891)
rpm..2100
Bore and stroke, mm(in.)........................136x152 (5.37x6)
No of cylinders...6
Displacement, litre (in.^{3})...........................13.4(817)
Electrical system...24 Volt
AMA kW (HP) US Tax purposes..............................51(69.3)

*Rated horsepower output of standard engine complete with water pump, lubricating oil pump and fuel pump under SAE standard ambient temperature and barometric conditions of 99.2 kPa (29.38 in. Hgl) and 29.4°C (85°F).

**Flywheel horsepower output of standard engine as installed in this vehicle with addition of fan, air cleaner, alternator and air compressor. No deration required up to 3658 m (12,000 ft) altitude.

TORQUE CONVERTER

Single-stage, single-phase type, 2.08 to 1 stall ratio.

TRANSMISSION

Full-power shift, countershaft type, constant mesh.

Speeds	1st	2nd	3rd	4th
Fwd & Rev km/h	0-8.5	0-15.6	0-30.9	0-53.6
(mph)...........	(0-5.3)	(0-9.69)	(0-19.18)	(0-33.28)

DIFFERENTIALS

Power transfer.

AXLES

Heavy-duty type with full-floating axle shafts and planetary final drive. Four-wheel drive.
Front axle fixed, rear axle oscillates a total of 30°. Vertical wheel travel of 648 mm (25.5 in.)

STEERING

Articulated frame. Full hydraulic power with mechanical follow-up.

BRAKES

Service--Four-wheel, air-over-hydraulic, wedge-actuated shoe brakes with separate axle-by-axle operation. Operator's choice braking: left pedal neutralizes transmission and applies brakes, right pedal applies brakes only. Automatic, low-pressure - apply brake system with low-pressure warning buzzer. Parking-mechanical-type intermediate drive shaft.

HYDRAULIC SYSTEM

Type: Closed with pressure control 0.21 mPa (30 psi) and vacuum relief.
Raise boom in 7.1 sec. Lower boom in 5.1 sec.
Roll back bucket in 2.7 sec. Dump bucket in 1.6 sec.
Reservoir: Cylindrical type with (4) 152 x 457 mm (6" x 18") 5-micron filters for full-flow filtering, suction screen, removable full-diameter cover for quick servicing.
Pumps: Three-vane type, driven from accessory drive.
Main Hyd: Output at 2100 rpm and 6.89 mPa (1000) psi) 390 l/min (103 gpm).
Steering Hyd: Output at 2100 rpm and 6.89 mPa (1000 psi) 174 l/min (46 gpm).
Valve: Two-spool with relief valve.
Valve: Remote mounted
Relief valve pressure 17.24 mPa (2500 psi)
Cylinders (double-acting--hardened chrome plated piston rods).
Boom-Bore and Stroke(2)........................152 x 1270 mm (6 in. x 50 in.)
Bucket-Bore and Stroke(1).......................203 x 546 mm (8 in. x 21.5 in.)
Steering-Bore and Stroke(2).....................114 x 521 mm (4.5 in. x 20.5 in.)

HYDRAULIC CONTROLS

Boom circuit: Automatic kickout adjustable from operator's deck from ground level to full lift height.
Positions: Raise, hold, down pressure and float.
Bucket circuit: Bucket indicator provides visual indication of bucket positon.
Positions: Roll back, hold and dump.

SERVICE CAPACITIES: (Approx)

	Litre	(US GAL)
Cooling system.............................	61.7	(16.3)
Lube systems:		
Crankcase.................................	32.1	(8.5)
Transmission..............................	43.1	(11.4)
Differential and final drive, front......	22.3	(5.9)
Hydraulic system..........................	207.4	(54.8)
Fuel tank.................................	435.2	(115)

GAUGES: Color-coded

Air cleaner service indicator
Air pressure
Engine coolant temperature
Engine oil pressure
Fuel
Service meter
Torque converter oil temperature
Voltmeter

BUCKET TYPE

		GENERAL PURPOSE	GENERAL PURPOSE	GENERAL PURPOSE	SPADE NOSE ROCK
SAE	(cu yds)	(4.5)	(5.0)	(5.5)	(4.5)
Bucket Capacity	(cy yds)	(3.6)	(4.1)	(4.6)	(3.8)
Width-mm (in)		(130.5)	(130.5)	(130.5)	(130.5)
Max Mat'l Weight (lb/yd3)	Excavating	(3000)	(2700)	(2450)	(3000)
**Static-Tipping Load with ROPS, (lbs)	Straight	(32840)	(32600	(31900)	(31810)
	Full Turn	(28000)	(27800)	(27100)	(27100)
**Basic Operating Weight w/ROPS, (lbs) No Attachment Included		(46688)	(46828)	(47348)	(47508)
*Dump Clearance, Max, Height and 45° Dump Angle--ft-in		(9 ft, 10.6 in.)	(9 ft, 10.6 in.)	(9 ft, 7.1 in.)	(9 ft, 6.7 in.)
*Reach @ 2/13m(7') Cut-Edge Clearance and 45° @ Dump Angle-- Ft-in		(6 ft, 2.3 in.)	(6 ft, 2.3 in.)	(6 ft, 4.8 in.)	(6 ft, 5.2 in.)
*Reach at Max Height and 45° Dump Angle-- ft-in		(4 ft, 10.7 in.)	(4 ft, 10.7 in.)	(5 ft, 2.2 in.)	(5 ft, 2.6 in.)
Overall Length, Bucket on Ground--ft-in		(27 ft, 7.5 in.)	(27 ft, 7.5 in.)	(28 ft, 0.5 in.)	(28 ft, 1 in.)
Overall Length, Bucket @ (19") Carry--ft-in		(28 ft, 0 in.)	(28 ft, 0 in.)	(28 ft, 3.8 in.)	(28 ft, 4.2 in.)
Turning Radius, Outside Corner of Bucket--Ft-in			(23 ft, 4 in.)	(23 ft, 5.5 in.)	(23 ft, 2.5 in.)

Lifting Capacity @ SAE Carry (lbs)	(44571)	(43644)	(43725)
Breakout Force, (lbs)	(38800)	(35159)	(34828)

*Increases or decreases according to tire size--refer to machine dimensions--all dimensions and weights per SAE J-732C.

**Machine stability and weight can be increased for stockpile loading by adding larger tires, ballast or counterweights, proper selection of optional equipment for optimum machine performance depends upon material weight and operating conditions.

PETTIBONE BP-419 LOADER/BACKHOE

SPECIFICATIONS

ENGINE

Make..G.M. Detroit Diesel
Model...4-53, 4 valve
Maximum Horsepower..115
Rated R.P.M...2400
Net Torque, ft-lbs..262
R.P.M. of Maximum Torque..................................1800
Number of Cylinders...4
Bore and Stroke..................................3 7/8 x 4 1/2
In^3 Displacement.......................................212
Air Cleaner.......................................Dry Type

ELECTRICAL SYSTEM

Voltage..12
Alternator...42 Amp
Ground..Neg
Battery Reserve Capacity, Minutes.........................310

TRANSMISSION

Make.......................................Allison Power Shift
Torque Converter
Type...............................2-Stage, 2-Phase, 4-Element
Torque Converter Stall Ratio.............................5.1 to 1
Range Selections.........................2 fwd, 1 neutral, 1 rev
Speed Ranges..................................4 fwd, 2 rev
Oil Cooler..................................Engine-Mounted

AXLES

Type...Planetary Drive
Front Differential..............................High Traction
Rear Differential....................................No Spin
Tread Width, Inches....................................73 1/2
Width Outside Tires, Inches...............................92

BRAKES

Air Over Hydraulic.....................................4-Wheel
Surface $in.^2$...560
Parking Brake Mechanical........................On Drive Shaft

TIRES

Standard Front and Rear..........................18.4 x 26; 10-Ply
Power Industrial Tractor

Optional Tires..................................17.5 x 25; 12-Ply
Sure-Grip Loader

SPEEDS, MPH

	FORWARD AND REVERSE
Low	0-5
High	0-19
Reverse	0-6

STEERING-ARTICULATED

Type	Full Time Power
Pump GPM @ 2400 RPM	22 ft.
Turning Rad Inside Wheels	12 ft, 4 in.
Turning Rad Outside Bucket	21 ft, 7 in.
Total Steering	60°

HYDRAULIC SYSTEM

Type	Vented System
Pump	Vane Type
Pump GPM @ 2400 RPM	70
Main Relief Valve Setting, PSI	2250
Individual Backhoe Cylinder Port Relief Valve Setting, PSI	3300
Oil Cooler Cap	1200 BTUs per min

FILTER

Return Line	10 Micron

HYDRAULIC CYLINDERS

	BORE	STROKE	ROD DIA
Backhoe			
Boom	5 1/2 in.	53 1/2 in.	3 in.
Dipper	5 1/2 in.	50 1/4 in.	3 1/2 in.
Bucker	4 in.	45-11/16 in.	3 in.
Stabilizer(2)	5 in.	19-1/16 in.	3 in.
Swing(2)	4 1/2 in.	21 1/2 in.	2 in.
Loader			
Life(2)	4 1/2 in.	25-7/8 in.	2 1/2 in.
Bucket (2)	3 1/2 in.	34 1/2 in.	2 in.

BACKHOE

Maximum Digging Depth	19 ft, 2 in.
Reach From Rear Axle	25 ft, 9 in.
Dumping Height	14 ft, 6 in.
Stabilizer Width on Ground	12 ft, 8 in.
Stabilizer Reach Below Wheel Level	2 ft, 2 1/2 in.
Bucket Cap. S.A.E. Rated Yd^3	1/2
Backhoe Rotation	180°

BACKHOE DIGGING FORCES

Breakout Force
  Dipperstick, lb......................................14,500
  Backhoe Bucket, lb...................................15,500

BACKHOE-LIFTING CAPACITY (lb)

At Bucket-Hinge Pin
  Boom and Dipper extended using Boom Cylinder................4200
Boom raised using Dipper Cylinder.............................7800

LOADER (SELF-LEVELING)

Bucket Width, inches..94
S.A.E. Rated Cap., Yd^3.....................................1 1/2
Carry Cap 50% Tipping Load lb.................................10,500
Lift Cap to Full Height lb....................................6,750
Breakout Force lb...14,600
Roll Back at Ground Level.....................................42°
Dumping Angle...45°
Dumping Clearance...8 ft, 9 in.
Dumping Reach...2 ft, 3 in.

PIVOT PIN DIAMETERS

Swing-Bracket Pivot...3 in.
Backhoe Boom Pivot..3 in.
Stabilizer Pivot..2 1/4 in.
Loader-Lift Arm Pivot...2 in.
Loader-Lift Cylinder Pivot....................................2 in.
Dipper Stick Pivot..2 1/2 in.
Bucket-Link Pivot on Dipper...................................2 in.
Dipper Cylinder Base..2 1/4 in.
Backhoe Swing Linkage...1 3/4 in.
Bucket Cylinder Base End......................................2 1/4 in.
Dipper Cylinder Rod End.......................................2 1/4 in.
All Others..2 in.

CAPACITIES

Fuel, Gallons...35
Cooling Systems, qt...25
Transmission, qt..[illegible]
Hydraulic System, gal...75
Hydraulic Reservoir, gal......................................45

DIMENSIONS

Transport Length..28 ft, 6 1/2 in.
Travel Height...13 ft, 2 1/2 in.
Wheel Base..8 ft, 8 in.
Ground Clearance..1 ft, 3 1/2 in.
Overall Width @ Loader Bucket.................................7 ft, 10 in.

APPROXIMATE WEIGHT LB.

Front Axle	8480
Rear Axle	16310
Total	24790

STANDARD EQUIPMENT

Self-leveling loader bucket, stabilizers, power steering, muffler, rear wheel fenders, neutral safety starting switch, loader bucket level indicator, headlights, rear lights, combination stop and tail lights, parking brake, tool box, instrument panel cover, clutch cutoff.

Instruments: Engine oil press, engine temperature, ammeter, fuel, tack-hour-meter, hydraulic oil temperature, converter temperature, Transmission clutch press, air press gauge.

OPTIONAL EQUIPMENT

Various backhoe bucket widths, rubber stabilizer street pads, various backhoe control lever arrangements, backhoe ripper tooth, Drott 4-in-1 loader bucket, cold-weather starting kit, California-certified ROPS cab or roll bar, Nelson side-dump bucket with heavy duty boom arms, maxibrake emergency and parking brake, turn signal lights, side-mount rear vision mirror, reverse warning alarm, revolving amber flasher light.

Pettibone Corporation reserves the right to change specifications without notice, to follow its policy of constantly striving to manufacture a better product, and without incurring liability, to incorporate these changes in previous models.

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